U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE **TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 USC 371 AND 37 CFR 1.491**	ATTORNEY DOCKET NO. 440566/PALL U.S. APPLICATION NO. 10/088175

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/US00/25092	14 SEPTEMBER 2000	17 SEPTEMBER 1999

TITLE OF INVENTION
METHODS AND SYSTEMS FOR COUNTING PARTICLES AND SENSING WATER

APPLICANT(S) FOR DO/EO/US
PALL CORPORATION

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 USC 371 and 37 CFR 1.491.

2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 USC 371 and 37 CFR 1.491.

3. ☒ This is an express request to begin national examination procedures (35 USC 371(f)).

4. ☐ The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).

5. ☒ A copy of the International Application as filed (35 USC 371(c)(2))
   a. ☐ is attached hereto (required only if not communicated by the International Bureau).
   b. ☐ has been communicated by the International Bureau.
   c. ☒ is not required, as the application was filed in the United States Receiving Office (RO/US).

6. ☐ An English language translation of the International Application as filed (35 USC 371(c)(2)).

7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 USC 371(c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.

8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 USC 371(c)(3)).

9. ☐ An oath or declaration of the inventor(s) (35 USC 371(c)(4)).

10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 USC 371(c)(5)).

11. Nucleotide and/or Amino Acid Sequence Submission
   a. ☐ Computer Readable Form (CRF)
   b. Specification Sequence Listing on:
      i. ☐ CD-ROM or CD-R (2 copies); or
      ii. ☐ Paper Copy
   c. ☐ Statement verifying identity of above copies

Items 12 to 19 below concern other document(s) or information included:

12. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
   ☐ Form PTO-1449
   ☐ Copies of Listed Documents

13. ☐ An assignment for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.

14. ☒ A FIRST preliminary amendment.
   ☐ A SECOND or SUBSEQUENT preliminary amendment.

15. ☐ A substitute specification.

16. ☐ A change of power of attorney and/or address letter.

17. ☒ Application Data Sheet Under 37 CFR 1.76

18. ☒ Return Receipt Postcard

19. ☒ Other items or information: International Application No. WO 01/20323 A1 including the International Search Report; Form PCT/IB/304; Form PCT/IB/308; Form PCT/IB/332; Form PCT/IPEA/402

JC13 Rec'd PCT/PTO 15 MAR 2002

U.S. APPLICATION NO.	INTERNATIONAL APPLICATION NO.	ATTORNEY DOCKET NO.
10/088175	PCT/US00/25092	440566/PALL

20. ☒ The following fees are submitted:	CALCULATIONS	PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5)):		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO $1,040.00		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO $890.00		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO, but international search fee (37 CFR 1.445(a)(2)) paid to USPTO $740.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) $710.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1) to (4) $100.00		
ENTER APPROPRIATE BASIC FEE AMOUNT=	$710.00	
Surcharge of $130.00 for furnishing the National fee or oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date	$	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total Claims	35 -20=	15	x $ 18.00	$270.00	
Independent Claims	3 - 3 =	0	x $ 84.00	$	
☐ Multiple Dependent Claim(s) (if applicable)			+$280.00	$	

TOTAL OF ABOVE CALCULATIONS=	$	
☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.	$	
SUBTOTAL=	$	
Processing fee of **$130.00** for furnishing English Translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date.	$	
TOTAL NATIONAL FEE=	$	
Fee for recording the enclosed assignment. The assignment must be accompanied by an appropriate cover sheet. **$40.00** per property +	$	
TOTAL FEE ENCLOSED=	$980.00	
	Amount to be: refunded	$
	charged:	$

a. ☒ A check in the amount of $980.00 to cover the above fee is enclosed.

b. ☐ Please charge Deposit Account No. 12-1216 in the amount of $ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 12-1216. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

23548
PATENT TRADEMARK OFFICE

John M. Belz, Reg. No. 30,359
LEYDIG, VOIT & MAYER, LTD.
700 Thirteenth Street, N.W., Suite 300
Washington, DC 20005-3960
(202) 737-6770 (telephone)
(202) 737-6776 (facsimile)

Date: 15 Mar 2002

#2/2

PATENT
Attorney Docket No. 440566

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Leonard E. BENSCH et al.

Art Unit: Unassigned

United States National Phase of
International Application
No. PCT/US00/25092

Examiner: Unassigned

Filed: September 14, 2000

For: METHODS AND SYSTEMS FOR COUNTING PARTICLES AND SENSING WATER

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Prior to calculation of the filing fee and examination of the above-identified patent application, please enter the following amendments and consider the following remarks.

IN THE CLAIMS:

Cancel claims 8, 9, 11, 17, 20, 31, 32, and 34-36.

Replace the indicated claims with:

3. The system of claim 1 wherein the water sensor is disposed downstream of the optical particle counter.

4. The system of claim 1 wherein the water sensor is disposed upstream of the optical particle counter.

5. The system of claim 1 wherein the water sensor and the optical particle counter are disposed in parallel in the non-aqueous liquid.

6. The system of claim 1 wherein the water sensor generates a signal indicative of relative saturation water content.

7. The system of claim 1 wherein the water sensor generates a signal indicative of absolute water content.

10. The system of claim 1 wherein the optical particle counter generates a signal indicative of the number of particles in the non-aqueous liquid.

12. The system of claim 1 further comprising a processing circuit operatively coupled to at least one of the water sensor and the optical particle counter.

14. The system of claim 12 wherein the processing circuit receives a signal indicative of the particle count from the optical particle counter.

15. The system of claim 12 wherein the processing circuit signals implications of the water content on the particle count.

16. The system of claim 15 wherein the processing circuit signals implications of the water content on the particle count in accordance with one or more threshold values related to the water content.

18. The system of claim 15 wherein the processing circuit provides an indication of the particle count and an indication of the reliability of the particle count in accordance with the water content.

19. The system of claim 18 wherein the processing circuit provides an indication of the reliability of the particle count in accordance with one or more threshold values related to the water content.

21. The system of claim 12 further comprising a valve arrangement coupled to the processing circuit.

23. The system of claim 22 further comprising a treatment unit coupled to the valve arrangement and arranged to decrease the water content in the non-aqueous liquid.

25. The system of claim 21 further comprising a bypass line coupled to the valve arrangement and arranged to bypass the optical particle counter.

26. The system of claim 1 wherein the water sensor and the optical particle counter comprise an integral unit.

33. The method claim 27 further comprising providing an indication of the reliability of the number of particles counted by the optical particle counter.

40. The method of claim 37 wherein directing the non-aqueous liquid away from the optical particle counter includes bypassing the optical particle counter.

41. The method of claim 37 wherein directing the non-aqueous liquid away from the optical particle counter includes directing the non-aqueous liquid into a particulate indicator.

44. The method of claim 37 wherein sensing an indication of the water content includes sensing an indication of the relative saturation water content of the non-aqueous liquid.

45. The method of claim 37 wherein sensing an indication of the water content includes sensing an indication of the absolute water content of the non-aqueous liquid.

In re Appln. of Leonard L. BENSCH et al.
Application No. Unassigned

REMARKS

These amendments are intended to eliminate multiple dependencies, to better present the claims for examination, and to reduce the filing fee by reducing the number of dependent claims. The canceled claims are cancelled without prejudice to resubmit them at a later date.

Respectfully submitted,

LEYDIG, VOIT & MAYER, LTD.

John M. Belz
Registration No. 30,359

Suite 300
700 Thirteenth Street, N.W.
Washington, D.C. 20005
Telephone: (202) 737-6770
Facsimile: (202) 737-6776
Dated: 15 Mar 2002

PATENT
Attorney Docket No. 440566

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Leonard E. BENSCH et al.

Art Unit: Unassigned

International Application
No. PCT/US00/25092

Examiner: Unassigned

Filed: September 14, 2000

For: METHODS AND SYSTEMS FOR COUNTING PARTICLES AND SENSING WATER

AMENDMENTS TO CLAIMS
MADE VIA PRELIMINARY AMENDMENT

Amendments to existing claims:

3. The system of claim 1 ~~or 2~~ wherein the water sensor is disposed downstream of the optical particle counter.

4. The system of claim 1 ~~or 2~~ wherein the water sensor is disposed upstream of the optical particle counter.

5. The system of claim 1 ~~or 2~~ wherein the water sensor and the optical particle counter are disposed in parallel in the non-aqueous liquid.

6. The system of claim 1 ~~any preceding claim~~ wherein the water sensor generates a signal indicative of relative saturation water content.

7. The system of claim 1 ~~any of claims 1-5~~ wherein the water sensor generates a signal indicative of absolute water content.

10. The system of claim 1 ~~any preceding claim~~ wherein the optical particle counter generates a signal indicative of the number of particles in the non-aqueous liquid.

12. The system of claim 1 ~~any preceding claim~~ further comprising a processing circuit operatively coupled to at least one of the water sensor and the optical particle counter.

14. The system of claim 12 ~~or 13~~ wherein the processing circuit receives a signal indicative of the particle count from the optical particle counter.

15. The system of claim 12 ~~any of claim 12-14~~ wherein the processing circuit ~~includes a subcircuit which~~ signals implications of the water content on the particle count.

16. The system of claim 15 wherein the ~~subcircuit~~ processing circuit signals implications of the water content on the particle count in accordance with one or more threshold values related to the water content.

18. The system of claim ~~17~~ 15 wherein the ~~display~~ processing circuit provides an indication of the particle count and an indication of the reliability of the particle count in accordance with the water content.

19. The system of claim 18 wherein the ~~display~~ processing circuit provides an indication of the reliability of the particle count in accordance with one or more threshold values related to the water content.

21. The system of claim 12 ~~any of claims 12-20~~ further comprising a valve arrangement coupled to the processing circuit.

23. The system of claim 22 ~~any of claims 21 and 22~~ further comprising a treatment unit coupled to the valve arrangement and arranged to decrease the water content in the non-aqueous liquid.

25. The system of claim 21 ~~any of claims 21-24~~ further comprising a bypass line coupled to the valve arrangement and arranged to bypass the optical particle counter.

26. The system of claim 1 ~~any of the preceding claims~~ wherein the water sensor and the optical particle counter comprise an integral unit.

33. The method claim 27 ~~31 or 32~~ further comprising ~~displaying~~ providing an indication of the reliability of the ~~displayed~~ number of particles counted by the optical particle counter.

40. The method of claim 37 ~~any of claims 37-39~~ wherein directing the non-aqueous liquid away from the optical particle counter includes bypassing the optical particle counter.

41. The method of claim 37 ~~any of claims 37-40~~ wherein directing the non-aqueous liquid away from the optical particle counter includes directing the non-aqueous liquid into a particulate indicator.

44. The method of claim 37 ~~any of claims 27-43~~ wherein sensing an indication of the water content includes sensing an indication of the relative saturation water content of the non-aqueous liquid.

45. The method of claim 37 ~~any of claims 27-43~~ wherein sensing an indication of the water content includes sensing an indication of the absolute water content of the non-aqueous liquid.

PATENT
Attorney Docket No. 440566

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Leonard E. BENSCH et al.

Art Unit: Unassigned

International Application
No. PCT/US00/25092

Examiner: Unassigned

Filed: September 14, 2000

For: METHODS AND SYSTEMS FOR COUNTING PARTICLES AND SENSING WATER

PENDING CLAIMS AFTER ENTRY OF PRELIMINARY AMENDMENT

1. A system for sampling a non-aqueous liquid comprising:

a water sensor capable of being coupled to a non-aqueous liquid to sense an indication of the water content of the non-aqueous liquid; and

an optical particle counter capable of being coupled to the non-aqueous liquid to provide an indication of the number of particulates present in the non-aqueous liquid.

2. The system of claim 1 wherein the water sensor and the optical particle counter are disposed in a slipstream of the non-aqueous liquid.

3. The system of claim 1 wherein the water sensor is disposed downstream of the optical particle counter.

4. The system of claim 1 wherein the water sensor is disposed upstream of the optical particle counter.

5. The system of claim 1 wherein the water sensor and the optical particle counter are disposed in parallel in the non-aqueous liquid.

6. The system of claim 1 wherein the water sensor generates a signal indicative of relative saturation water content.

7. The system of claim 1 wherein the water sensor generates a signal indicative of absolute water content.

10. The system of claim 1 wherein the optical particle counter generates a signal indicative of the number of particles in the non-aqueous liquid.

12. The system of claim 1 further comprising a processing circuit operatively coupled to at least one of the water sensor and the optical particle counter.

13. The system of claim 12 wherein the processing circuit receives a signal indicative of the water content from the water sensor.

14. The system of claim 12 wherein the processing circuit receives a signal indicative of the particle count from the optical particle counter.

15. The system of claim 12 wherein the processing circuit signals implications of the water content on the particle count.

16. The system of claim 15 wherein the processing circuit signals implications of the water content on the particle count in accordance with one or more threshold values related to the water content.

18. The system of claim 15 wherein the processing circuit provides an indication of the particle count and an indication of the reliability of the particle count in accordance with the water content.

19. The system of claim 18 wherein the processing circuit provides an indication of the reliability of the particle count in accordance with one or more threshold values related to the water content.

21. The system of claim 12 further comprising a valve arrangement coupled to the processing circuit.

22. The system of claim 21 wherein the processing circuit and the valve arrangement are arranged to direct non-aqueous liquid away from the optical particle counter in accordance with the signal indicative of the water content.

23. The system of claim 22 further comprising a treatment unit coupled to the valve arrangement and arranged to decrease the water content in the non-aqueous liquid.

24. The system of claim 23 wherein the treatment unit includes an outlet coupled to the optical particle counter.

25. The system of claim 21 further comprising a bypass line coupled to the valve arrangement and arranged to bypass the optical particle counter.

26. The system of claim 1 wherein the water sensor and the optical particle counter comprise an integral unit.

27. A method for sampling a non-aqueous liquid comprising:

directing the non-aqueous liquid into an optical particle counter and generating a signal indicative of the number of particles present in the non-aqueous liquid and

sensing the water content of the non-aqueous liquid.

28. The method of claim 27 wherein the non-aqueous liquid is directed into the optical particle counter after sensing the water content of the non-aqueous liquid.

29. The method of claim 27 wherein the non-aqueous liquid is directed into the optical particle counter before sensing the water content of the non-aqueous liquid.

30. The method of claim 27 wherein the non-aqueous liquid is directed into the optical particle counter at substantially the same time as sensing the water content of the non-aqueous liquid.

33. The method claim 27 further comprising providing an indication of the reliability of the number of particles counted by the optical particle counter.

37. A method for sampling a non-aqueous liquid comprising:

sensing an indication of the water content of the non-aqueous liquid; and

in response to the water content indication either (1) directing the non-aqueous liquid into an optical particle counter and generating a signal indicative of the number of particles in the non-aqueous liquid or (2) directing the non-aqueous liquid away from the optical particle counter.

38. The method of any of claim 37 wherein directing the non-aqueous liquid away from the optical particle counter includes directing the non-aqueous liquid into a treatment unit which decreases the water content of the non-aqueous liquid.

39. The method of claim 38 further comprising directing the non-aqueous liquid from the treatment unit into an optical particle counter.

40. The method of claim 37 wherein directing the non-aqueous liquid away from the optical particle counter includes bypassing the optical particle counter.

41. The method of claim 37 wherein directing the non-aqueous liquid away from the optical particle counter includes directing the non-aqueous liquid into a particulate indicator.

42. The method of claim 41 wherein directing the non-aqueous liquid into a particulate indicator includes passing the non-aqueous liquid through a porous medium and sensing a characteristic of non-aqueous liquid flow through the porous medium.

43. The method of claim 42 wherein sensing a characteristic of non-aqueous liquid flow through the porous medium includes sensing the pressure differential across the porous medium.

44. The method of claim 37 wherein sensing an indication of the water content includes sensing an indication of the relative saturation water content of the non-aqueous liquid.

45. The method of claim 37 wherein sensing an indication of the water content includes sensing an indication of the absolute water content of the non-aqueous liquid.

Methods and Systems for Counting Particles and Sensing Water

TECHNICAL FIELD

The present invention relates to methods and systems that improve the reliability of optical particle counters by assessing the presence and/or influence of water. More particularly, the present invention relates to methods and systems that optically count particulates present in non-aqueous liquids, such as oils, fuels, and other hydrocarbons, while accounting for the deleterious effect on accurate particle readings caused by the presence of water in the non-aqueous liquids.

BACKGROUND OF THE INVENTION

Non-aqueous liquids, particularly hydrocarbons such as transformer oils, motor oils, transmission fluids, and fuels may become contaminated with particulates during use. These contaminated liquids cause corrosion, wear, mechanical damage to and/or poor performance in the systems in which they are used. Accordingly, it is desirable to detect the presence and quantity of particulates present in these systems to determine when the liquid must be cleaned, processed or replaced.

Several methods exist for detecting particulates in liquids, including non-aqueous liquids. In one method, a sample is taken from the fluid path to a testing facility, mixed with a reagent and the quantity of particulates determined. This method is inefficient as it requires excess time and often leads to inaccurate results caused by contamination during transfer. In another method the liquid is redirected through a slipstream where the liquid is filtered for particulates. The quantity of particulates in the liquid may be inferred by sensing the change in the pressure drop across the filter. This method is reactionary and is ineffective in accurately counting the particulates present and maximizing utilization of the liquid.

In yet another method, a sample is taken, for example, in a slipstream, and the particulates are counted by an optical particle counter. This method is generally highly efficient, and, under the appropriate conditions, extremely accurate. However, counts from optical particle counters are dramatically influenced by the level of water present in a non-aqueous liquid. In many instances, erroneous counts are produced by the presence of water and the operator has no convenient, real time method to know that the counts are wrong. Some conventional solutions solved this problem by using methods, such as heating, to remove the water from the non-aqueous liquid to be tested so that a proper count could be achieved.

However, this method may adversely affect the non-aqueous liquid and fails to address the combinatorial effect of water and particulate contamination on non-aqueous liquids.

Summary of the Invention

According to one aspect of the invention, systems for sampling a non-aqueous liquid may include both an optical particle counter and a water sensor. The optical particle counter generates a signal indicative of the number of particles in the non-aqueous liquid, and the water sensor generates a signal indicative of the water content of the non-aqueous liquid.

According to another aspect of the present invention, methods for sampling a non-aqueous liquid may include directing a non-aqueous liquid into an optical particle counter and sensing the water content of the non-aqueous liquid.

Systems and methods embodying these aspects of the invention thus allow an operator to easily determine whether the particle count is suspect due to the water content of the non-aqueous liquid. If the water content reaches a level that may negatively influence the particle count, the operator knows that the particle count may be unreliable and he may take appropriate action.

According to another aspect of the present invention, methods for sampling a non-aqueous liquid may include sensing the water content of a non-aqueous liquid. The methods may further include directing the non-aqueous liquid to or away from an optical particle counter in response to the water content.

In systems and methods embodying this aspect of the invention, the non-aqueous liquid may be directed to the optical particle counter if the water content is below a value that can negatively influence the particle count. If the water content reaches a value where the optical counter will likely produce an erroneous result, the non-aqueous liquid may be redirected away from the optical particle counter. When the non-aqueous liquid is directed away from the optical particle counter, various embodiments provide for alternative particulate indicators, treatment units for decreasing the water content, and/or bypass lines.

Description of the Drawings

Figure 1 illustrates a system for sampling a non-aqueous liquid.

Figure 2 illustrates another system for sampling a non-aqueous liquid.

Figure 3 illustrates another system for sampling a non-aqueous liquid.

Figure 4 illustrates another system for sampling a non-aqueous liquid.

Detailed Description of the Invention

Counting particulates and sensing the water content of non-aqueous liquids, such as transformer oils, motor oils, transmission fluids, and fuels, may be accomplished by operatively coupling corresponding sensors to the non-aqueous liquid in a variety of locations. For example, the sensors may be operatively located directly in a main stream of the non-aqueous liquid or in a slipstream, e.g., a flow of the non-aqueous liquid through a secondary path. Using a slipstream for testing is generally preferable, although it is not required, so as to avoid affecting the main stream, for example, when sensors malfunction or require routine maintenance. Alternatively, the optical particle counter and/or the water sensor may be operatively coupled to the non-aqueous liquid in a reservoir or a container, such as a tank or bottle.

Examples of systems for sampling a non-aqueous liquid, including counting particles and sensing water content, are illustrated in Figures 1 and 2. The sampling systems 20, 21 generally comprise an optical particle counter 1 and a water sensor 2, which may be disposed to sample the non-aqueous liquid in a slipstream 4 that is redirected away from and back toward a main stream 3. The optical particle counter 1 and the water sensor 2 may be operatively coupled to the non-aqueous liquid in series, with the optical particle counter 1 upstream, preferably closely upstream, of the water sensor 2, as shown in Figure 1, or with the optical particle counter downstream, preferably closely downstream, of the water sensor. Alternatively, as shown in Figure 2, the optical particle counter 1 and the water sensor 2 may be operatively coupled to the non-aqueous liquid in parallel. The water sensor 2 and the optical counter 1 are preferably placed sufficiently close in proximity that one of these components samples substantially similar portions of the non-aqueous liquid, e.g., the same portion of the non-aqueous liquid, soon after the other, as shown in Figure 1, or at approximately the same time as the other, as in Figure 2. The optical particle counter 1 and the water sensor 2 may be implemented as separate components which sample the non-aqueous liquid separately, or they may be implemented as an integral unit which senses the number of particles and the water content in a sample of non-aqueous liquid at substantially the same time.

A wide variety of optical particle counters may be utilized with embodiments of the invention. Optical particle counters are preferred because of their accuracy and reliability in counting particulates present in a liquid. Many conventional optical particle counters comprise a chamber for testing a liquid, a light source that produces a beam of light that is received through a slit into the chamber and reflected through the liquid, and a measuring device for measuring the amount of obscuration or scattering caused in the beam of light. These and other optical systems provide particularly accurate counts under appropriate conditions. Optical particle counters are

readily available from many companies, including Pacific Scientific, that make a full line of optical counters that count particulates with various degrees of accuracy.

Similarly, a wide variety of water sensors may be utilized with embodiments of the invention. For example, several water sensors are disclosed in International Publication No. WO 98/46984, entitled "Methods and Systems for Sensing Water in Liquids", assigned to Pall Corporation, and incorporated herein by reference. Water sensors may measure absolute water content, relative saturation water content or both. Water sensors may be implemented in a variety of ways. For example, many conventional water sensors measure the change in potential across a sample of non-aqueous liquid caused by the increase in conductivity due to the presence of water. Water sensors may also include temperature sensors to account for changes in the water content with temperature variations. Water sensors are readily available from many companies, including Vaisala Company and Pall Corporation.

In a preferred mode of operation, a portion of the non-aqueous liquid flowing in the main stream 3 may be directed into the slipstream 4, past the optical particle counter 1 and the water sensor 2, and back to the main stream 3. The non-aqueous liquid may be directed past the optical particle counter before, after or at substantially the same time that the non-aqueous liquid is directed past the water sensor, depending, for example, on whether the optical particle counter is upstream, downstream, in parallel with, or integrated with the water sensor. As the non-aqueous liquid flows past the optical particle counter 1, it generates a signal indicative of the number of particles in the non-aqueous liquid. As the non-aqueous liquid flows past the water sensor, it generates a signal indicative of the water content of the non-aqueous liquid.

The optical particle counter 1 and the water sensor 2 may each comprise a processing circuit and a display that receive the various signals produced by their corresponding counting or sensing implementation and produce a visual indication indicative of the results, which may then be interpreted by an operator. The visual indication may be a readout of the particle count or the water content. The water sensor may provide a different visual indication, e.g., one which simply indicates one or more water content ranges. With the water sensor 2 and the optical particle counter 1 sufficiently close, the operator may conveniently and reliably utilize the visual indication of the water sensor to determine the implications of the water content on the particle count. The water sensor thus provides a reliability indicator to determine if the optical particle counter is producing a reliable result due to the presence of water in the non-aqueous liquid. For many non-aqueous liquids, a higher water content may indicate a less reliable particle count.

Another example of a system for sampling a non-aqueous liquid is shown in Fig. 3. The system 22 includes an optical particle counter 1 and a water sensor 2 disposed in a slipstream 4 of a main stream 3 with the optical particle counter 1 upstream of the water sensor 2. However,

the optical particle counter and the water sensor may be operatively coupled to the non-aqueous liquid in any other suitable manner, as previously described. For example, the optical particle counter and the water sensor may be disposed in the main stream, may be disposed in series with the water sensor upstream of the optical particle counter, may be disposed in parallel or may be integrated with one another.

The sampling system 22 may further include a processing circuit 5 and a display 6. The processing circuit 5 may be coupled to at least one of and preferably both of the optical particle counter 1 and the water sensor 2. The display 6 may be coupled to at least one of the optical particle counter 1, the water sensor 2, and the processing circuit 5, preferably at least the processing circuit 5. In the illustrated embodiment, the processing circuit 5 is shown as a separate component and it may be implemented in any suitable manner, e.g., as a general purpose computer, a microprocessor, a logic array, or any other suitable processing circuitry. Similarly, the display 6 is shown as a separate component, and it may be implemented in any suitable manner, e.g., as a CRT or a flat panel display and/or one or more lightable indicators. However, the processing circuit or the display or both may be integral components of one another, the optical particle counter and/or the water sensor. For example, the processing circuit and the display may be implemented as a computer with a flat panel or CRT display and the computer may be connected to an integral unit comprising the optical particle counter and the water sensor. Regardless of how the processing circuit is implemented, the processing circuit may store data received from the optical particle counter and/or the water sensor so it may be viewed immediately or at a later time by the operator. The processing circuit may also download the data to other processing circuits, e.g., computers for further display or analysis.

In a preferred mode of operation, a portion of the non-aqueous liquid may be directed from the main stream 3 into the slipstream 4, past the optical particle counter 1 and the water sensor 2, and back to the main stream 3, as previously described. As the non-aqueous liquid flows past the optical particle counter 1 and the water sensor 2, they respectively generate a signal indicative of the number of particles in the non-aqueous liquid and a signal indicative of the water content of the non-aqueous liquid.

The processing circuit 5 may respond to the signals input from the optical particle counter 1 and/or water sensor 2 in a variety of ways. For example, the processing circuit 5 may receive a signal indicating water content from the water sensor 2 and a signal indicating the particle count from the optical particle counter 1 and then simply generate display signals. The display signals may be transferred to the display 6 and result in a readout of the particle count as determined by the optical particle counter 1 and a visual indication of the water content, e.g., a readout of the water content, as determined by the water sensor 2. As disclosed with respect to the

embodiments shown in Figures 1 and 2, the water content indication of the water sensor provides a reliability indicator for the particle count. If the reliability indicator indicates that the particle count is sufficiently unreliable, the operator may simple ignore the count.

Alternatively, the processing circuit 5 may include one or more subcircuits for further processing signals input from the optical particle counter 1 and/or the water sensor 2. For example, the processing circuit 5 may include a threshold subcircuit which may store one or more threshold values. Each threshold value may correspond to a water content in a given non-aqueous liquid which calls into question a particle count produced by the optical particle counter 1. For example, for a given non-aqueous liquid the particle count may be substantially accurate below a first predetermined water content value, e.g., below a relative saturation value of, say, up to 90% or more; may be somewhat inaccurate between the first predetermined water content value and a second predetermined water content value, e.g., between relative saturation values of, say, 90% and up to about 100% or more; and may be substantially inaccurate above the second predetermined water content value, e.g., above the relative saturation value of 100%. Values of 90% and 100% for the first and second predetermined water content values, respectively, are merely exemplary. Each predetermined water content value may vary depending on factors such as the nature of the non-aqueous liquid and the type of optical particle counter and may be determined empirically.

The threshold subcircuit may store the predetermined value(s), e.g., the first and second predetermined values, as the threshold values and may compare them to the water content signal received from the water sensor. The threshold subcircuit may be configured in any suitable manner for storing the threshold value(s) and performing the comparison. For example, the threshold subcircuit may be implemented as a memory containing a threshold lookup table, a comparator for comparing the water content signal with the stored threshold values, and control logic for determining a course of action based on the comparison results. The processing circuit 5 may then generate a display signal indicative of the number of particles in the non-aqueous liquid and one or more display signals in accordance with the output of the threshold subcircuit.

The display 6 may be configured in a variety of ways to provide an indication of the particle count and an indication of the water content as a reliability indicator for the displayed particle count. For example, the display 6 may include several lightable indicators, e.g., green, yellow, and red lamps, in addition to a particle count readout. Depending on the output of the threshold subcircuit and, in turn, the display signals generated by the processing circuit 5: (1) the green lamp may be lit if the water content is in a first reliability range, i.e., below the first threshold value, signalling the operator that the displayed particle count is likely to be substantially accurate; (2) the yellow lamp may be lit if the water content is in a second

reliability range, i.e., between the first and second threshold values, signalling the operator that the displayed particle count is likely to somewhat inaccurate; and (3) the red lamp may be lit if the water content is in a third reliability range, i.e., above the second threshold value, signalling the operator that the displayed particle count is likely to be substantially inaccurate. While the threshold subcircuit and the display have been described in terms of two threshold values and three reliability ranges, more or fewer threshold values and reliability ranges may be provided. Further, while the reliability ranges have been implemented in the display by lightable indicators such as lamps, other visual indications and/or audible indications, such as alarms, may be used.

In yet another alternative, the processing circuit may include circuitry which adjusts the indication of the particle count input from the particle counter 1 in accordance with the indication of the water content input from the water sensor 2. For example, the water content in a given non-aqueous liquid may falsely increase, or decrease, the particle count sensed by the optical particle counter 1. The relationship between the water content and the excess counts, or the count shortfall, may be empirically determined for the non-aqueous liquid and implemented in the processing circuit 5, e.g., in an adjustment subcircuit. This implementation may be configured in a variety of ways, including a lookup table or a logic array. In any event, the adjustment subcircuit may operate on the signal input from the optical particle counter 1 in accordance with the signal input from the water sensor 2 to provide an adjusted indication of the particle count which more accurately represents the true particle count. The processing circuit 5 may then generate a display signal in accordance with an adjusted particle count signal and transfer the display signal to the display 6. The display 6 may then provide a readout of the adjusted particle count. The display 6 may also provide a reliability indication such as a readout of the water content or a visual indication of the reliability range. However, because the processing circuit 5 has adjusted the sensed particle count in accordance with the sensed water content to provide an adjusted, more accurate particle count, a reliability indicator may not be included with the display 6.

Another example of a system for sampling a non-aqueous liquid is shown in Figure 4. The sampling system 23 includes an optical particle counter 1, a water sensor 2, and a display 6 coupled to a processing circuit 5, as shown in Figure 3. The optical particle counter 1 and the water sensor 2 are disposed in a slipstream 4 of a main stream 3 with the optical particle counter 1 downstream of the water sensor 2. However, the components of this system may be implemented in other suitable configurations and disposed in the non-aqueous liquid in any other suitable manner, such as those previously described with respect to the embodiments of Figures 1-3. For example, the optical particle counter and the water sensor may be disposed in the main stream, may be disposed in series with the water sensor downstream of the optical particle

counter, or may be disposed in parallel. However, in this embodiment, the optical particle counter and the water sensor are preferably not located at the same point in the non-aqueous liquid stream.

The sampling system further includes a valve arrangement coupled to the processing circuit 5. The valve arrangement may be implemented in a wide variety of ways. In the illustrated embodiment, the valve arrangement comprises first, second, and third valves 7, 8, 9, each coupled to the processing circuit 5. The valve arrangement allows the non-aqueous liquid to be directed to the optical particle counter 1 or away from the optical particle counter 1 in accordance with the water content sensed by the water sensor 2. For example, the processing circuit 5 may receive a water content signal input from the water sensor 2 and determine if the water content is within or outside of a range in which the optical particle counter 1 provides a reliable, accurate particle count. This function may be implemented, for example, in a threshold subcircuit similar to the threshold subcircuit previously described. If the water content is within the range, the processing circuit 5 may generate a valve control signal which operates the first valve 7 to direct the non-aqueous liquid from the water sensor 2 into the optical particle counter 1. A readout of the particle count and a reliability indicator may then be displayed on the display 6. If the water content is outside of the range in which the optical particle counter 1 provides a reliable, accurate particle count, the processing circuit 5 may generate a valve control signal which operates the first valve 7 to direct the non-aqueous liquid away from the optical particle counter 1.

When the non-aqueous liquid is directed away from the optical particle counter 1, it may be directed along a wide variety of suitable alternative flow paths. For example, the sampling system may include a treatment unit 10 which operates to decrease the water content in the non-aqueous liquid. The treatment unit may be implemented in a wide variety of suitable ways, including as a coalescing and/or separating assembly or a heater. The processing circuit 5 may generate a valve control signal which operates the second valve 6 to direct non-aqueous liquid into the treatment unit 10. Once the water content of the non-aqueous liquid has been decreased, the non-aqueous liquid may be directed back to the optical particle counter 1 to obtain a more accurate particle count. The non-aqueous liquid may pass directly from an output of the treatment unit 10 to the optical particle counter 1. The optical particle counter 1 may then provide a signal indicative of a particle count to the processing circuit 5 which then may be displayed on the display 6. However, because the particle count sensed by the optical particle counter 1 is based on a non-aqueous liquid having a lower water content than that sensed by the water sensor 2, the reliability indicator shown on the display 6 may be disabled. Alternatively, a second water sensor (not shown) may be operatively coupled to the non-aqueous liquid flow path

between the treatment unit and the optical particle counter and may be coupled to the processing circuit. Consequently, when the processing circuit directs the non-aqueous liquid through the treatment unit, past the second water sensor, and to the optical particle counter, it may display the count indicated by the optical particle counter and the water content indicated by the second water sensor.

Alternatively, or additionally, when the non-aqueous liquid is directed away from the optical particle counter 1, it may simply be directed to a bypass line which returns the non-aqueous liquid to the main stream 4. For example, the processing circuit 5 may generate valve control signals which operate the second and third valves 8, 9 to direct the non-aqueous liquid through a bypass line 14 coupled to the slipstream 4 and hence the main stream 3. The processing circuit 5 and the display 6 may be configured in any suitable manner which provides an indication that the optical particle counter is being bypassed.

As yet another alternative, or addition, when the non-aqueous liquid is directed away from the optical particle counter it may be directed to another particulate indicator 11, for example, any particulate indicator other than an optical particle counter which is less sensitive to water content. Preferably, the particulate indicator 11 includes a porous medium, such as a porous mesh, through which the non-aqueous liquid flows. A fluid flow characteristic, such as differential pressure across the porous medium, is sensed to provide an indication of the quantity of particulates in the non-aqueous liquid. The particulate indicator 11 may generate a signal indicative of the quantity of particulates sensed and the signal may be provided to the processing circuit 5. The processing circuit 5, in turn, may display the particulate indication on the display 6, with or without the reliability indicator. From the particulate indicator 11, the non-aqueous liquid may be returned to the main stream 3.

The sampling system 23 shown in Figure 4 may operate independently of any main system controller or it may operate in conjunction with a main system controller. For example, the processing circuit 5 may be coupled to a system controller 12 to provide a variety of data and instructions between them. For example, the processing circuit 5 may relay the water content signal provided by the water sensor 2, the particle count signal generated by the optical particle counter 1, and/or the particulate signal generated by the particulate indicator 11 to the system controller 12. Depending on the value of the signals, the system controller 12 may then control the main system in a variety of ways. For example, if the water content or the particulate content as indicated by the water sensor 2, the optical particle counter 1 or the particulate indicator 11 is unusually high, the system controller may shut off the main stream 3, e.g., by operating a main valve 13 accordingly.

Various aspects of the invention have been described with respect to many embodiments. However, the invention is not limited to these embodiments. For example, one or more of the features of any of these embodiments may be combined with one or more of the features of the other embodiments without departing from the scope of the invention. Further, one or more of the features of any of these embodiments may be modified or omitted without departing from the scope of the invention. Accordingly, the various aspects of the invention include any and all methods and systems encompassed within the spirit and scope of the invention as defined by the following claims.

What is claimed is:

1. A system for sampling a non-aqueous liquid comprising:

a water sensor capable of being coupled to a non-aqueous liquid to sense an indication of the water content of the non-aqueous liquid; and

an optical particle counter capable of being coupled to the non-aqueous liquid to provide an indication of the number of particulates present in the non-aqueous liquid.

2. The system of claim 1 wherein the water sensor and the optical particle counter are disposed in a slipstream of the non-aqueous liquid.

3. The system of claim 1 or 2 wherein the water sensor is disposed downstream of the optical particle counter.

4. The system of claim 1 or 2 wherein the water sensor is disposed upstream of the optical particle counter.

5. The system of claim 1 or 2 wherein the water sensor and the optical particle counter are disposed in parallel in the non-aqueous liquid.

6. The system of any preceding claim wherein the water sensor generates a signal indicative of relative saturation water content.

7. The system of any of claims 1-5 wherein the water sensor generates a signal indicative of absolute water content.

8. The system of any preceding claim wherein the water sensor provides a display indicative of water content.

9. The system of claim 8 wherein the water sensor provides the display in accordance with one or more threshold values.

10. The system of any preceding claim wherein the optical particle counter generates a signal indicative of the number of particles in the non-aqueous liquid.

11. The system of any preceding claim wherein the optical particle counter provides a display indicative of the number of particles in the non-aqueous liquid.

12. The system of any preceding claim further comprising a processing circuit operatively coupled to at least one of the water sensor and the optical particle counter.

13. The system of claim 12 wherein the processing circuit receives a signal indicative of the water content from the water sensor.

14. The system of claim 12 or 13 wherein the processing circuit receives a signal indicative of the particle count from the optical particle counter.

15. The system of any of claim 12-14 wherein the processing circuit includes a subcircuit which signals implications of the water content on the particle count.

16. The system of claim 15 wherein the subcircuit signals implications of the water content on the particle count in accordance with one or more threshold values related to the water content.

17. The system of any of claims 12-16 further comprising a display coupled to at least one of the optical particle counter, the water sensor, and the processing circuit.

18. The system of claim 17 wherein the display provides an indication of the particle count and an indication of the reliability of the particle count in accordance with the water content.

19. The system of claim 18 wherein the display provides an indication of the reliability of the particle count in accordance with one or more threshold values related to the water content.

20. The system of any of claims 17-19 wherein the display provides a readout of the particle count and/or an indication of the water content.

21. The system of any of claims 12-20 further comprising a valve arrangement coupled to the processing circuit.

22. The system of claim 21 wherein the processing circuit and the valve arrangement are arranged to direct non-aqueous liquid away from the optical particle counter in accordance with the signal indicative of the water content.

23. The system of any of claims 21 and 22 further comprising a treatment unit coupled to the valve arrangement and arranged to decrease the water content in the non-aqueous liquid.

24. The system of claim 23 wherein the treatment unit includes an outlet coupled to the optical particle counter.

25. The system of any of claims 21-24 further comprising a bypass line coupled to the valve arrangement and arranged to bypass the optical particle counter.

26. The system of any of the preceding claims wherein the water sensor and the optical particle counter comprise an integral unit.

27. A method for sampling a non-aqueous liquid comprising:

directing the non-aqueous liquid into an optical particle counter and generating a signal indicative of the number of particles present in the non-aqueous liquid and

sensing the water content of the non-aqueous liquid.

28. The method of claim 27 wherein the non-aqueous liquid is directed into the optical particle counter after sensing the water content of the non-aqueous liquid.

29. The method of claim 27 wherein the non-aqueous liquid is directed into the optical particle counter before sensing the water content of the non-aqueous liquid.

30. The method of claim 27 wherein the non-aqueous liquid is directed into the optical particle counter at substantially the same time as sensing the water content of the non-aqueous liquid.

31. The method of any of claims 27-30 further comprising displaying an indication of the number of particles.

32. The method of claim 31 wherein displaying an indication of the number of particles includes displaying a readout of the number of particles.

33. The method claim 31 or 32 further comprising displaying an indication of the reliability of the displayed number of particles.

34. The method of any of claims 31-33 further comprising displaying an indication of the water content.

35. The method of claim 34 wherein displaying an indication of the water content includes displaying a readout of the water content.

36. The method of claim 34 or 35 wherein displaying an indication of the water content includes displaying an indication of one or more water content ranges.

37. A method for sampling a non-aqueous liquid comprising:

sensing an indication of the water content of the non-aqueous liquid; and

in response to the water content indication either (1) directing the non-aqueous liquid into an optical particle counter and generating a signal indicative of the number of particles in the non-aqueous liquid or (2) directing the non-aqueous liquid away from the optical particle counter.

38. The method of any of claim 37 wherein directing the non-aqueous liquid away from the optical particle counter includes directing the non-aqueous liquid into a treatment unit which decreases the water content of the non-aqueous liquid.

39. The method of claim 38 further comprising directing the non-aqueous liquid from the treatment unit into an optical particle counter.

40. The method any of claims 37-39 wherein directing the non-aqueous liquid away from the optical particle counter includes bypassing the optical particle counter.

41. The method of any of claims 37-40 wherein directing the non-aqueous liquid away from the optical particle counter includes directing the non-aqueous liquid into a particulate indicator.

42. The method of claim 41 wherein directing the non-aqueous liquid into a particulate indicator includes passing the non-aqueous liquid through a porous medium and sensing a characteristic of non-aqueous liquid flow through the porous medium.

43. The method of claim 42 wherein sensing a characteristic of non-aqueous liquid flow through the porous medium includes sensing the pressure differential across the porous medium.

44. The method of any of claims 27-43 wherein sensing an indication of the water content includes sensing an indication of the relative saturation water content of the non-aqueous liquid.

45. The method of any of claims 27-43 wherein sensing an indication of the water content includes sensing an indication of the absolute water content of the non-aqueous liquid.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

CORRECTED VERSION

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
22 March 2001 (22.03.2001)

PCT

(10) International Publication Number
WO 01/020323 A1

(51) International Patent Classification[7]: G01N 33/28, 15/14

(21) International Application Number: PCT/US00/25092

(22) International Filing Date:
14 September 2000 (14.09.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/154,597 17 September 1999 (17.09.1999) US

(71) Applicant *(for all designated States except US)*: **PALL CORPORATION** [US/US]; 2200 Northern Boulevard, East Hills, NY 11548-1209 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **BENSCH, Leonard, E.** [US/US]; 24 Branding Iron Lane, Glen Cove, NY 11542 (US). **REED, Ian** [GB/GB]; 28 Sennen Place, Port Solent, Portsmouth, Hampshire P06 4SZ (GB). **SIMKINS, Robert** [US/US]; 21 Old Hills Lane, Greenlawn, NY 11740 (US). **NEEDLEMAN, William** [US/US]; 8 Hillside Court, Huntington, NY 11743 (US).

(74) Agent: **BELZ, John, M.**; Leydig, Voit & Mayer, Ltd., 700 Thirteenth Street, N.W., Suite 300, Washington, DC 20005 (US).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

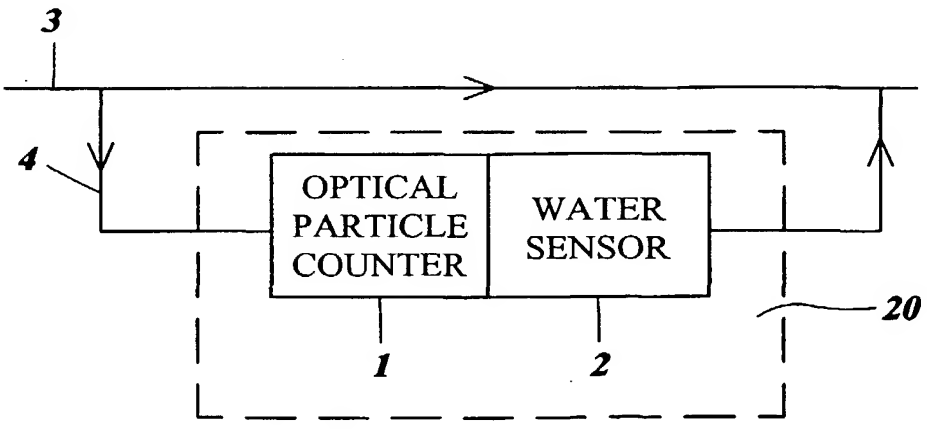
Published:
— *with international search report*

(48) Date of publication of this corrected version:
3 October 2002

(15) Information about Correction:
see PCT Gazette No. 40/2002 of 3 October 2002, Section II

[Continued on next page]

(54) Title: METHODS AND SYSTEMS FOR COUNTING PARTICLES AND SENSING WATER

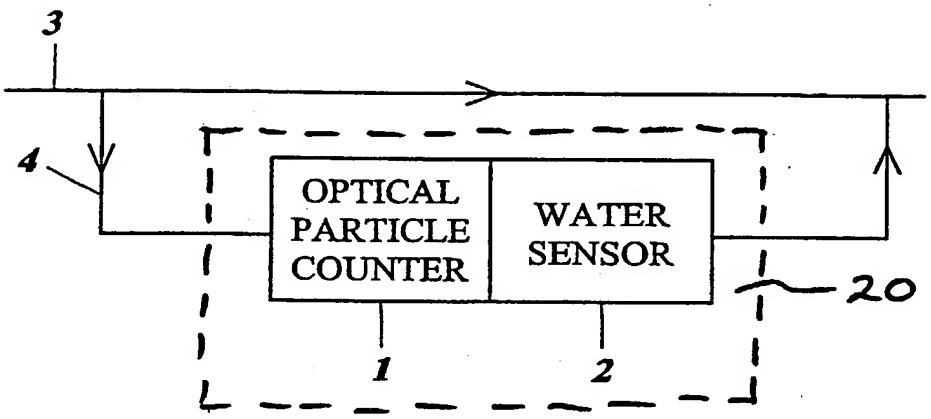


(57) Abstract: A system (20) for sampling a non-aqueous liquid comprises an optical particle counter (1) and a water sensor (2).

WO 01/020323 A1

WO 01/020323 A1

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.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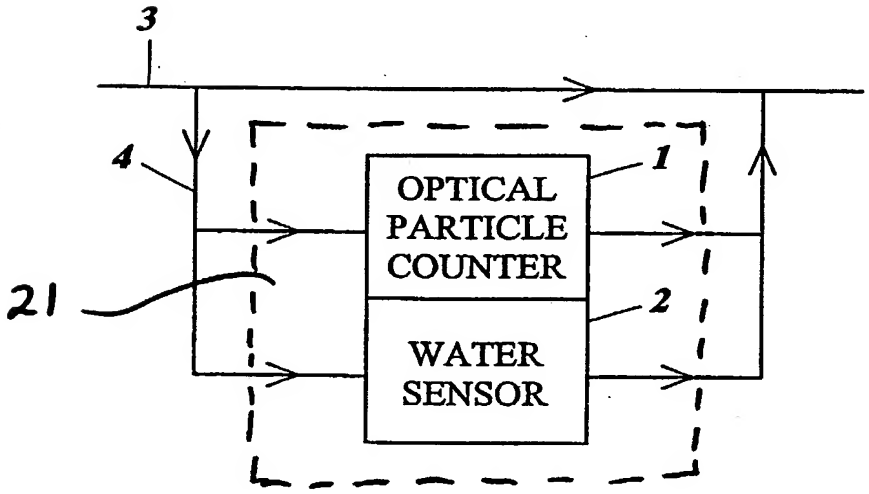
OPTICAL PARTICLE COUNTER
WATER SENSOR
20
1
2

FIG. 1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4
1
OPTICAL PARTICLE COUNTER
21
2
WATER SENSOR

FIG. 2

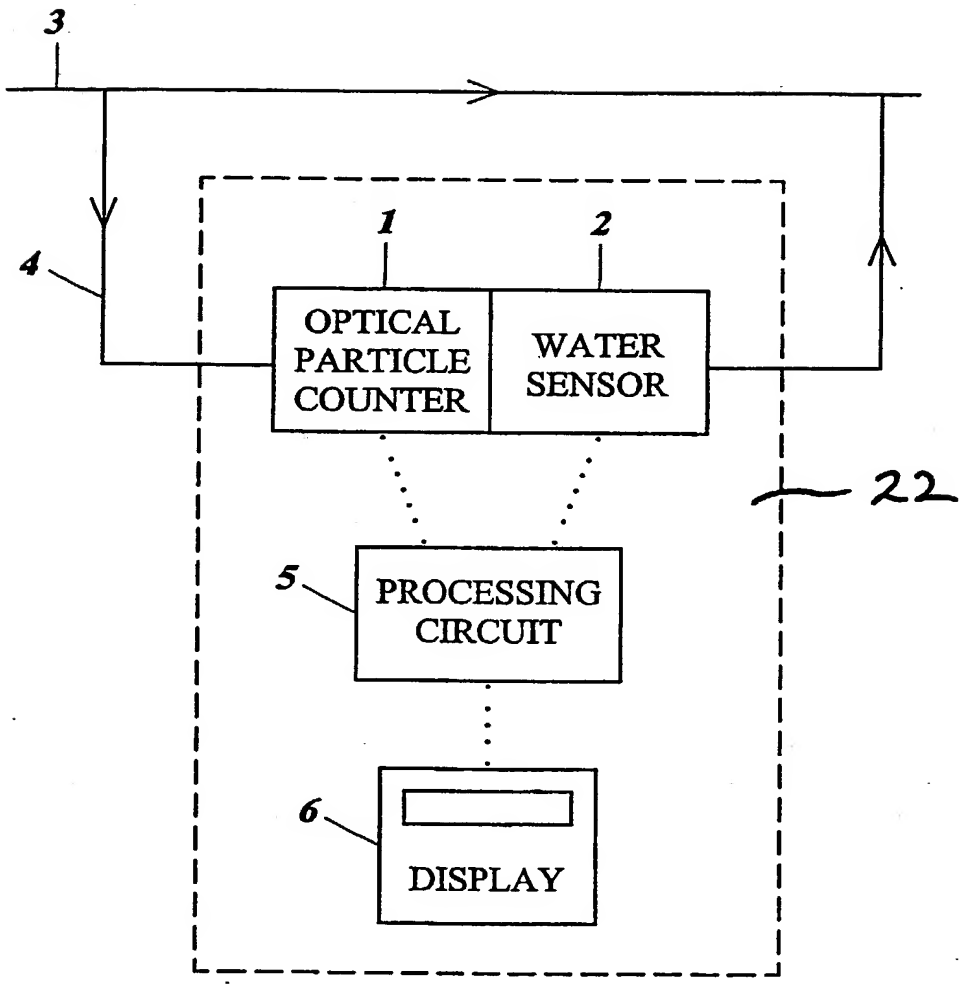
3
1
2
4
OPTICAL PARTICLE COUNTER
WATER SENSOR
22
5
PROCESSING CIRCUIT
6
DISPLAY

FIG. 3

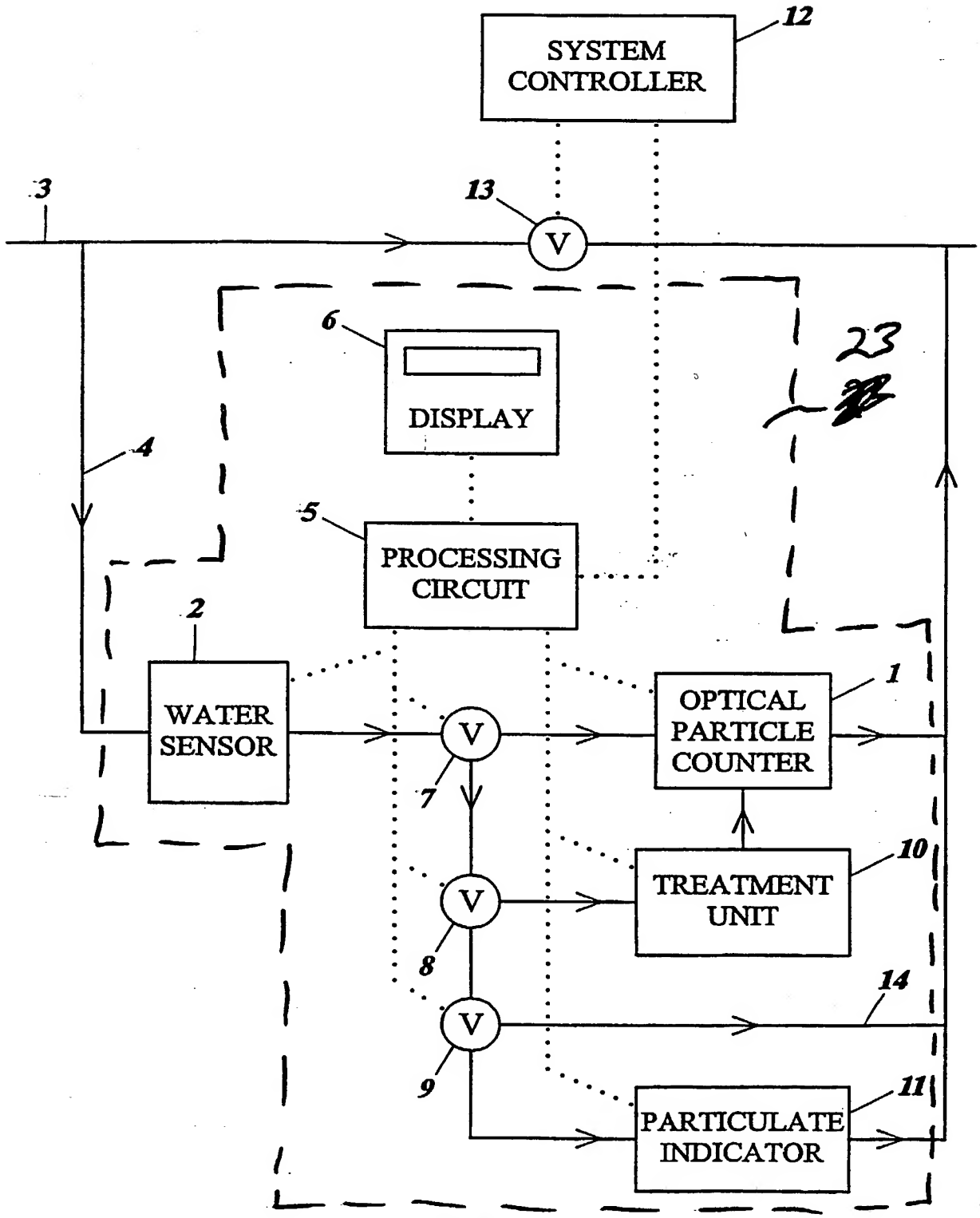
SYSTEM CONTROLLER
12
3
13
V
6
DISPLAY
23
4
5
PROCESSING CIRCUIT
2
WATER SENSOR
V
1
OPTICAL PARTICLE COUNTER
7
V
10
TREATMENT UNIT
8
14
V
9
11
PARTICULATE INDICATOR

FIG. 4

PATENT
Attorney Docket No. 440566

COMBINED DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION AND POWER OF ATTORNEY

☐ Declaration Submitted with Initial Filing OR
☒ Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16(e)) required)

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name. I believe I am the original, first, and sole inventor *(if only one name is listed below)* or an original, first, and joint inventor *(if plural names are listed below)* of the subject matter which is claimed and for which a patent is sought on the invention entitled:

METHODS AND SYSTEMS FOR COUNTING PARTICLES AND SENSING WATER

the specification of which:

☐ is attached hereto.
☐ was filed on as Application No. and was amended on *(if applicable)*.
☐ was filed by Express Mail No. *as Application No. not known yet*, and was amended on *(if applicable)*.
☒ was filed on September 14, 2000 as PCT International Application No. PCT/US00/25092 and entered the United States National Phase as United States Application Number 10/088,175.

I state that I have reviewed and understand the contents of the specification identified above, including the claim(s), as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I claim foreign priority benefits under 35 USC 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application(s) designating at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application(s) for patent, utility model, design registration, inventor's or plant breeder's rights certificate(s), or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter and having a filing date before that of the application(s) from which the benefit of priority is claimed.

Prior Foreign Application(s) Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Claimed YES	Priority Claimed NO	Certified Copy Attached? YES	Certified Copy Attached? NO
			☐	☐	☐	☐
			☐	☐	☐	☐
			☐	☐	☐	☐
			☐	☐	☐	☐

In re Appln. of BENSCH et al.
Attorney Docket No. 440566

As a named inventor, I hereby appoint Leydig, Voit & Mayer to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: Customer Number 23548.

I further direct that correspondence concerning this application be directed to Leydig, Voit & Mayer: Customer Number 23548.

I declare that all statements made herein of my own knowledge are true, that all statements made on information and belief are believed to be true, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

1-00

Full name of sole or first inventor: Leonard E. BENSCH

Inventor's signature Leonard E Bensch

Date 12-04-02

Country of Citizenship: USA

Residence: Glen Cove, New York NY
(city/state or country)

Post Office Address: 24 Branding Iron Lane, Glen Cove, New York 11542 USA

Full name of second joint inventor, if any: Ian REED

Inventor's signature _____

Date _____

Country of Citizenship: UK

Residence: Hampshire, England
(city/state or country)

Post Office Address: 28 Sennen Place, Port Solent, Portsmouth, Hampshire PO6 4SZ England

...no. 440566

As a named inventor, I hereby appoint Leydig, Voit & Mayer to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: Customer Number 23548.

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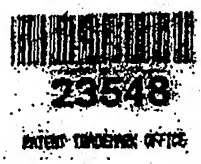

I declare that all statements made herein of my own knowledge are true, that all statements made on information and belief are believed to be true, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole or first inventor: Leonard E. BENSCH

Inventor's signature _____

Date _____ Country of Citizenship: USA

Residence: Glen Cove, New York
(city/state or country)

Post Office Address: 24 Branding Iron Lane, Glen Cove, New York 11542 USA

2-00

Full name of second joint inventor, if any: Ian REED

Inventor's signature _____

Date 10/12/02 Country of Citizenship: UK

Residence: Hampshire, England GBR
(city/state or country)

Post Office Address: 28 Sennen Place, Port Solent, Portsmouth, Hampshire PO6 4SZ England

In re Applo. of BENSCH et al.
Attorney Docket No. 440566

3-00

Full name of third joint inventor, if any: Robert G. SIMKINS

Inventor's signature _____

Date 12/10/02

Country of Citizenship: USA

Residence: Greenlawn, New York NY
(city/state or country)

Post Office Address: 21 Old Hills Lane, Greenlawn, New York 11740 USA

Full name of fourth joint inventor, if any: William M. NEEDLEMAN

Inventor's signature _____

Date _____

Country of Citizenship: USA

Residence: Huntington, New York
(city/state or country)

Post Office Address: 8 Hillside Court, Huntington, New York 11743 USA

In re Appln. of BENSCH et al.
Attorney Docket No. 440566

Full name of **third joint inventor,** if any: **Robert G. SIMKINS**

Inventor's signature _____

Date _____ Country of Citizenship: USA

Residence: Greenlawn, New York
(city/state or country)

Post Office Address: 21 Old Hills Lane, Greenlawn, New York 11740 USA

4-0

Full name of **fourth joint inventor,** if any: **William M. NEEDLEMAN**

Inventor's signature William M. Needleman

Date 11 Dec 2002 Country of Citizenship: USA

Residence: Huntington, New York NY
(city/state or country)

Post Office Address: 8 Hillside Court, Huntington, New York 11743 USA

Declaration (Revised 7/6/2002)

PATENT
Attorney Docket No. 440566

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METHODS AND SYSTEMS FOR COUNTING PARTICLES AND SENSING WATER

the specification of which:

☐ is attached hereto.
☐ was filed on as Application No. and was amended on *(if applicable)*.
☐ was filed by Express Mail No. *as Application No. not known yet*, and was amended on *(if applicable)*.
☒ was filed on **September 14, 2000** as PCT International Application No. **PCT/US00/25092** and entered the United States National Phase as United States Application Number **10/088,175**.

I state that I have reviewed and understand the contents of the specification identified above, including the claim(s), as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

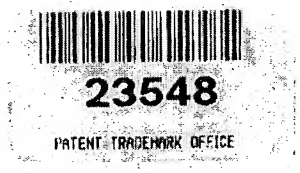
I claim foreign priority benefits under 35 USC 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application(s) designating at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application(s) for patent, utility model, design registration, inventor's or plant breeder's rights certificate(s), or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter and having a filing date before that of the application(s) from which the benefit of priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Claimed YES	Priority Claimed NO	Certified Copy Attached? YES	Certified Copy Attached? NO
			☐	☐	☐	☐
			☐	☐	☐	☐
			☐	☐	☐	☐
			☐	☐	☐	☐

In re Appln. of BENSCH et al.
Attorney Docket No. 440566

As a named inventor, I hereby appoint Leydig, Voit & Mayer to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: Customer Number 23548.

I further direct that correspondence concerning this application be directed to Leydig, Voit & Mayer: Customer Number 23548.



I declare that all statements made herein of my own knowledge are true, that all statements made on information and belief are believed to be true, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

1-00 Full name of **sole or first inventor: Leonard E. BENSCH**

Inventor's signature _____

Date _____ Country of Citizenship: USA

Residence: Glen Cove, New York NY
(city/state or country)

Post Office Address: 24 Branding Iron Lane, Glen Cove, New York 11542 USA

2-00 Full name of **second joint inventor,** if any: **Ian REED**

Inventor's signature _____

Date _____ Country of Citizenship: UK

Residence: Hampshire, England GBR
(city/state or country)

Post Office Address: 28 Sennen Place, Port Solent, Portsmouth, Hampshire P06 45Z England

In re Appln. of BENSCH et al.
Attorney Docket No. 440566

3-00

Full name of **third joint inventor,** if any: **Robert G. SIMKINS**

Inventor's signature _____

Date _____ Country of Citizenship: USA

Residence: Greenlawn, New York NY
(city/state or country)

Post Office Address: 21 Old Hills Lane, Greenlawn, New York 11740 USA

4-00

Full name of **fourth joint inventor,** if any: **William M. NEEDLEMAN**

Inventor's signature _____

Date _____ Country of Citizenship: USA

Residence: Huntington, New York NY
(city/state or country)

Post Office Address: 8 Hillside Court, Huntington, New York 11743 USA

Declaration (Revised 7/6/2002)